Claims

[1] A hydrogen generator comprising:

a reformer configured to conduct a steam reforming reaction to reform a material to generate a reformed gas containing carbon monoxide, water and hydrogen;

a shift converter configured to conduct a shift reaction using the carbon monoxide and steam in the reformed gas;

a water supply device configured to supply the water to said reformer;

a material feed device configured to feed the material to said reformer; and

a controller configured to count the number of times of start-up and/or stop of said hydrogen generator and to increase a temperature or a S/C ratio of the reformed gas flowing in said shift converter according to the counted number of times of start-up and/or stop.

[2] The hydrogen generator according to claim 1, further comprising:

a reformed gas temperature adjusting device configured to cool and heat the reformed gas flowing into said shift converter;

wherein said controller controls said reformed gas temperature adjusting device to increase the temperature of the reformed gas according to the counted number of times of start-up and/or stop.

[3] The hydrogen generator according to claim 1,

wherein said controller controls said water supply device and said material feed device to increase the S/C ratio of the reformed gas according to the counted number of times of start-up and/or stop.

[4] The hydrogen generator according to claim 1, further comprising:

a reformed gas temperature adjusting device configured to cool and heat the reformed gas flowing into said shift converter;

wherein said controller counts an accumulated operation time of said hydrogen generator, and controls said reformed gas temperature adjusting device to increase the temperature of the reformed gas according to the counted number of times of start-up and/or stop and the counted accumulated operation time of said hydrogen generator.

[5] The hydrogen generator according to claim 1, wherein said controller counts an accumulated operation time of said hydrogen generator, and controls said water supply device and said material feed device to increase the S/C ratio of the reformed gas according to the counted number of times of start-up and/or stop and the counted accumulated operation time of said hydrogen generator.

[6] The hydrogen generator according to claim 1, further comprising:

a temperature detector configured to detect the temperature of the reformed gas at an inlet of said shift converter from which the reformed gas flows into said shift converter;

wherein, at re-start-up after stop of said hydrogen generator, said controller obtains a detected value from said temperature detector, compares the detected value to a temperature condition of water condensation, and counts the number of times of start-up and/or stop of said hydrogen generator when the detected value matches the temperature condition of water condensation.

[7] The hydrogen generator according to claim 2,

wherein said controller pre-stores controlled temperature data such that a controlled temperature corresponds to the number of times of start-up and/or stop;

and wherein said controller selects the controlled temperature from the controlled temperature data according to the counted number of times of start-up and/or stop and controls said reformed gas temperature adjusting device so that the temperature of the reformed gas becomes the selected controlled temperature.

[8] The hydrogen generator according to claim 3,

wherein said controller pre-stores controlled S/C ratio data such that a controlled S/C ratio corresponds to the number of times of start-up and/or stop;

and wherein said controller selects the controlled S/C ratio from the controlled S/C ratio data according to the counted number of times of start-up and/or stop and controls said water supply device and said material feed device so that the S/C ratio of the reformed gas becomes the selected controlled S/C ratio.

[9] The hydrogen generator according to claim 7,

wherein said controller counts the accumulated operation time of said hydrogen generator;

and wherein said controller selects the controlled temperature from the controlled temperature data according to the counted number of times of start-up and/or stop and the counted accumulated operation time, and controls said reformed gas temperature adjusting device so that a detected temperature from said temperature detector becomes the selected controlled temperature.

[10] The hydrogen generator according to claim 8,

wherein said controller counts the accumulated operation time of said hydrogen generator;

and wherein said controller selects a controlled S/C ratio from the controlled S/C ratio data according to the counted number of times of start-up and/or stop and the counted accumulated operation time, and controls said water supply device and said material feed device so that the S/C ratio of the reformed gas becomes the selected controlled S/C ratio.

[11] The hydrogen generator according to claim 9,

wherein said controller stores controlled temperature data such that the controlled temperature corresponds to the number of times of start-up and/or stop and the accumulated operation time, selects the controlled temperature from the controlled temperature data according to the counted number of times of start-up and/or stop and the counted accumulated operation time, and controls said reformed gas temperature adjusting device so that the detected temperature from said temperature detector becomes the selected controlled temperature.

[12] The hydrogen generator according to claim 10,

wherein said controller stores controlled S/C ratio data such that the controlled S/C ratio corresponds to the number of times of start-up and/or stop and the accumulated operation time, selects the controlled S/C ratio from the controlled S/C ratio data according to the counted number of times of start-up and/or stop and the counted accumulated operation time, and controls said water supply device and said material feed device so that the S/C ratio of the reformed gas becomes the selected controlled S/C ratio.

[13] The hydrogen generator according to claim 7, further comprising:

an oxidizing agent supply device configured to add an oxidizing agent to the reformed gas that has flowed through said shift converter; and

a carbon monoxide selective oxidation device configured to conduct selective oxidation using the carbon monoxide and the oxidizing agent in the reformed gas;

wherein said controller pre-stores carbon monoxide concentration data such that a carbon monoxide concentration of the reformed gas after the shift reaction at the controlled temperature is associated with the controlled temperature;

and wherein said controller selects a carbon monoxide concentration corresponding to the selected controlled temperature from the carbon monoxide concentration data, calculates a controlled oxidizing agent flow rate from a reformed gas flow rate and the selected carbon monoxide concentration, and controls said oxidizing agent supply device to add the oxidizing agent to the reformed gas with the controlled oxidizing agent flow rate.

[14] The hydrogen generator according to claim 8, further comprising:

an oxidizing agent supply device configured to add an oxidizing agent to the reformed gas that has flowed through said shift converter; and

a carbon monoxide selective oxidation device configured to conduct selective oxidation using the carbon monoxide and the oxidizing agent in the reformed gas;

wherein said controller pre-stores carbon monoxide concentration data such that a carbon monoxide concentration of the reformed gas after the shift reaction in the controlled S/C ratio is associated with the controlled S/C ratio;

and wherein said controller selects a carbon monoxide concentration corresponding to the selected controlled S/C ratio from the carbon monoxide concentration data,

calculates a controlled oxidizing agent flow rate from a reformed gas flow rate and the selected carbon monoxide concentration, and controls said oxidizing agent supply device to add the oxidizing agent to the reformed gas with the controlled oxidizing agent flow rate.

[15] The hydrogen generator according to claim 2,

wherein said reformed gas temperature adjusting device is configured to adjust the temperature of the reformed gas by water-cooling the reformed gas in a reformed gas passage through which said reformer and said shift converter communicate with each other, and water that has cooled the reformed gas is supplied to said reformer.

[16] A fuel cell system comprising:

a fuel cell; and

a hydrogen generator according to claim 1;

said hydrogen generator being configured to supply as a fuel gas, to said fuel cell, a reformed gas that has flowed through said shift converter, and being configured to start-up and stop in association with an operation of said fuel cell and to adjust a supply amount of the reformed gas according to a power output of said fuel cell;

wherein said controller of said hydrogen generator is configured to count the number of times of start-up and/or stop of said fuel cell.

[17] A fuel cell system comprising:

a fuel cell; and

a hydrogen generator according to claim 9;

said hydrogen generator being configured to supply as a fuel cell, to said fuel cell, a reformed gas that has flowed through said shift converter, and being configured to start-up

and stop in association with an operation of said fuel cell and to adjust a supply amount of the reformed gas according to a power output of said fuel cell;

wherein said controller of said hydrogen generator is configured to count the number of times of start-up and/or stop of said fuel cell and an accumulated operation time of said fuel cell.

[18] A fuel cell system comprising:

a fuel cell; and

a hydrogen generator according to claim 10;

said hydrogen generator being configured to supply as a fuel gas, to said fuel cell, a reformed gas that has flowed through said shift converter, and being configured to start-up and stop in association with an operation of said fuel cell and to adjust a supply amount of the reformed gas according to a power output of said fuel cell;

wherein said controller of said hydrogen generator is configured to count the number of times of start-up and/or stop of said fuel cell and an accumulated operation time of said fuel cell.

[19] The hydrogen generator according to claim 1,

wherein said controller includes an output device that displays or outputs the counted number of times of start-up and/or stop.

[20] The hydrogen generator according to claim 1, further comprising:

a carbon monoxide concentration detector configured to detect a carbon monoxide concentration of the reformed gas that has flowed through said shift converter;

wherein said controller pre-stores an upper limit value of the carbon monoxide

concentration of the reformed gas;

and wherein said controller compares a detected value from said carbon monoxide concentration detector to the upper limit value, and increases the temperature or the S/C ratio of the reformed gas flowing in said shift converter when the detected value is larger than the upper limit value.

[21] A method of operating a hydrogen generator including a reformer configured to conduct a steam reforming reaction to reform a material to generate a reformed gas containing carbon monoxide, water and hydrogen; a shift converter configured to conduct a shift reaction using the carbon monoxide and steam in the reformed gas; a water supply device configured to supply the water to said reformer; and a material feed device configured to feed the material to said reformer, comprising the steps of:

counting the number of times of start-up and/or stop of said hydrogen generator; and

increasing a temperature or a S/C ratio of the reformed gas flowing in said shift converter according to the counted number of times of start-up and or stop.

[22] The method of operating a hydrogen generator according to claim 21, wherein said hydrogen generator further includes a reformed gas temperature adjusting device configured to cool and heat the reformed gas flowing into said shift converter, the method further comprising the step of:

increasing the temperature of the reformed gas by said reformed gas temperature adjusting device.

[23] The method of operating a hydrogen generator according to claim 21, further

comprising the step of increasing the S/C ratio of the reformed gas by said water supply device and said material feed device.

[24] The method of operating a hydrogen generator according to claim 21, wherein said hydrogen generator further includes an oxidizing agent supply device configured to add an oxidizing agent to the reformed gas that has flowed through said shift converter; and a carbon monoxide selective oxidation device configured to conduct selective oxidation using the carbon monoxide and the oxidizing agent in the reformed gas; the method further comprising the steps of:

storing controlled temperature data such that a controlled temperature corresponds to the number of times of start-up and /or stop and carbon monoxide concentration data such that a carbon monoxide concentration of the reformed gas after the shift reaction at a controlled temperature is associated with the controlled temperature;

selecting the controlled temperature from the controlled temperature data according to the counted number of times of start-up and/or stop;

adjusting the temperature of the reformed gas to become the selected controlled temperature by said reformed gas temperature adjusting device;

selecting a carbon monoxide concentration corresponding to the selected controlled temperature from the carbon monoxide concentration data;

calculating a controlled oxidizing agent flow rate from a reformed gas flow rate and the selected carbon monoxide concentration; and

adding an oxidizing agent to the reformed gas with the controlled oxidizing agent flow rate by said oxidizing agent supply device.

[25] The method of operating a hydrogen generator according to claim 21, wherein said

hydrogen generator further includes an oxidizing agent supply device configured to add an oxidizing agent to the reformed gas that has flowed through said shift converter; and a carbon monoxide selective oxidation device configured to conduct selective oxidation using the carbon monoxide and the oxidizing agent in the reformed gas; the method further comprising the steps of:

storing controlled S/C ratio data such that a controlled S/C ratio corresponds to the number of times of start-up and/or stop and carbon monoxide concentration data such that a carbon monoxide concentration of the reformed gas after the shift reaction corresponding to the controlled S/C ratio is associated with the controlled S/C ratio;

selecting the controlled S/C ratio from the controlled S/C ratio data according to the counted number of times of start-up and/or stop;

adjusting the S/C ratio of the reformed gas to become the selected controlled S/C ratio by said water supply device and said material feed device;

selecting a carbon monoxide concentration corresponding to the selected controlled S/C ratio from the carbon monoxide concentration data;

calculating a controlled oxidizing agent flow rate from the reformed gas flow rate and the selected carbon monoxide concentration; and

adding an oxidizing agent to the reformed gas with the controlled oxidizing agent flow rate by said oxidizing agent supply device.

[26] The method of operating a hydrogen generator according to claim 21, wherein said hydrogen generator includes an output device that displays or outputs the counted number of times of start-up and/or stop, the method further comprising:

increasing the temperature or the S/C ratio of the reformed gas flowing in said shift converter according to display or output of said output device.